

REMARKS

Applicant has amended Claim 1 to read: "A method consisting essentially of making a stamp for microcontact printing, said method substantially eliminating pattern distortion of said stamp formed as a result of said method, said method consisting essentially of..." This language places the making of a stamp for microcontact printing as a part of the body of the claim and not in the preamble thereof. The claim is specifically limited to a "stamp" by virtue of the "consisting essentially of" language in the claim.

The Examiner is respectfully requested to reconsider the rejection of Claims 1 and 8, under 35 U.S.C. 103(a) as being unpatentable over Dawes, et al. (U.S. Patent 6,511,615) in view of Sangokoya (U.S. Patent 5,731,253), further in view of Kumar, et al. (U.S. Patent 5,512,131).

Applicant respectfully points out that the Examiner has cited the reference to Dawes in the first line of each of the 35 U.S.C. 103(a) rejections, but in the body of the rejections uses the name "Muller" presumably as the reference. Applicant has responded to the Official Action using the "Dawes" reference even though many locations say "Muller."

The present invention forms a microcontact printing stamp which possesses a minimum degree of printing distortion. (Emphasis Added). The method of making the improved stamp of the present invention which stamp has a pattern for microcontact printing utilizes a siloxane composition as now defined specifically in Claim 1, wherein the siloxane composition is cured to fix its geometry while at or near the intended final use temperature (room temperature), followed by a higher temperature step to harden the siloxane composition, without substantially inducing geometry changes to the stamp and the pattern.

More particularly, the present invention comprises a simple technique with respect to microcontact printing stamps, to achieve both the required dimensional integrity for pattern faithfulness and desired mechanical properties, primarily high elastic modulus. It teaches that with the vinyl addition type siloxane precursor mixtures (and others), where crosslinking (curing)

can take place at either room temperature or higher temperature, a two-step cure produces the desired combination of properties.

The first step is a room temperature cure, since generally room temperature is the condition at which the stamp will be ultimately used. The stamp is allowed to crosslink at room temperature for some period. During Applicant's curing time, the stamp crosslinks and fixes the overall stamp geometry and the printing pattern in a manner far superior to and not contemplated by the prior art (See: e.g., Kumar, et al.)

After this curing step is completed, the second step commences wherein the stamp is brought to a much higher temperature, of between about 50 °C and 120 °C, at which temperature a further cure continues thus attaining a higher elastic modulus. Upon cooling back to room temperature, the original pattern is restored without distortion and the stamp has the desired higher modulus.

The two-step processing described above is used with the intention of using the first step to establish the precise dimension of the molded pattern. The step establishes not just the relative geometry, but also the resulting dimension by being held at a precise temperature within an enclosed mold. Then, once this dimension has been irrevocably established, the material is heated to a higher temperature for hardening.

Even though the material will (and does) expand during the higher temperature curing, it will (and does) shrink back to its original dimension again after cooling to the final use temperature.

Dawes discloses a planar optical device which is formed on a substrate. The device is essentially an array of waveguide cores which guide optical radiation. A cladding layer is formed contiguously with the array of waveguide cores to confine the optical radiation to the array of waveguide cores.

The teaching in the reference bears no relationship to the instant invention. Dawes does say that at least one of the array of waveguide cores and cladding layer is an inorganic-organic hybrid material that comprises an extended matrix containing silicon and oxygen atoms with at least a fraction of the silicon atoms being directly bonded to substituted or unsubstituted hydrocarbon moieties. This material can be designed with an index of refraction between 1.4 and 1.55 and can be deposited rapidly to thicknesses of up to 40 microns. Dawes states that the method for forming a planar optical device obviates the need for a lithographic process. This indicates the field to which Dawes is related.

The method of forming the waveguide cores involves: (1) preparing a waveguide core composition precursor material comprising at least one silane and a source of hydrocarbon moiety, (2) partially hydrolyzing and polymerizing the waveguide core precursor material to form a waveguide core composition, (3) using a mold, forming an array of waveguide cores comprising the waveguide core composition, and (4) completing hydrolysis and polymerization of the waveguide core composition under conditions effective to form an inorganic-organic hybrid material that comprises an extended matrix containing silicon and oxygen atoms with at least a fraction of the silicon atoms being directly bonded to substituted or unsubstituted hydrocarbon moieties. A cladding layer is then deposited over the array of waveguide cores. The use of the mold to pattern the array of waveguide cores obviates the need for a lithographic process.

This in no way relates to the instant invention other than disclosing the use of compounds containing silicon and oxygen. There is a two step test for determining whether a prior art reference is non-analogous and thus not relevant in determining obviousness. The steps are: whether the reference is within the field of the inventor's endeavor; and if not whether the reference is reasonable pertinent to the particular problem with which the inventor was involved. The claimed invention and referenced patent(s) are within the same field of endeavor if they have the same function and structure. See: *In re Deminski*, 796 F.2d 436, 230 USQ 313 (Fed. Cir. 1986).

There is no relationship between the "Hybrid organic-inorganic planar optical waveguide device" and the stamp of the present invention. The use of the products formed is found in two totally different endeavors. Dawes does not disclose the elements of Claim 1 as is set forth on page 4 of the Official Action.

The Dawes invention as noted above relates to a sol and curing a silicone composition to a solid condition by heat. While sol-gel processing is sometimes called "polymerization," the reaction mechanism is such that small molecules react into a 3-dimensional network, so that essentially an inorganic silica (quartz-like) species is formed - NOT a flexible elastomer stamp. Applicant's resultant product in Claim 1 is a "flexible soft elastomeric stamp." Applicant uses totally different chemistry resulting in a hard silica pattern, not a soft polymer elastomer for which such multistep and long-time cures are not known. The very use of the words "sol liquid" and "drying" distinguishes the Dawes disclosure from Applicant's invention as reactive polymers do not dry at all. They cure. Sol-Gel processes (which are not polymers) require very slow drying which is well known in the art. Indeed, sol-gel drying is an art/science all to itself and often involves use of techniques like freeze-drying or supercritical CO₂ extraction followed by slow drying.

Applicant has explained in his specification that there are a number of sources for severe pattern distortion in the standard curing process. One reason for the distortion is that each component of the mold, including the master with glass and photoresist, flexible backplane, spacers, and mold housing expands with temperature changes according to the CTE of each. Thus, each component of the structure, being made of a different material with a different coefficient of expansion, expands disproportionally relative to each other, and to the original intended pattern. These will be the dimensions in place at the time of curing when the siloxane hardens into a stamp, and the pattern becomes fixed.

At this point, with the oven hot and after sufficient time for curing, the stamp possesses a pattern dimension that is related to the original master pattern according to the composite CTE of the master glass and photoresist. As the glass and photoresist will have expanded more or less

uniformly, the stamp pattern will differ from the original in a relatively predictable way, which would be able to be reasonably compensated for by choice of an appropriately scaled master pattern to begin with. This sequence would produce a useful product if this were the end of the fabrication process, but it is not. Before the stamp is separated from the mold, the entire assembly must first be cooled down. During cooling, the master will shrink according to its moderate CTE (maybe 20 to 40 ppm). The stamp itself will shrink very significantly with a CTE of about 500 to 800 ppm, and the affixed backplane will shrink with a CTE of around 5 to 50 ppm, depending on the choice of material. It is this differential CTE between the permanently affixed backplane and the stamp that causes a complex pattern distortion that is sought to be avoided. Muller does not recognize this problem in his disclosure.

Dawes' objective is not to form a stamp with fine definition that is needed, as noted above, to reproduce items, but rather his objective is to produce a hybrid organic planar optical wave guide device. Dawes does not produce a microcontact printing stamp as the Examiner has asserted on page 4 of the Official Action.

Sangokoya discloses a process of producing aluminoxane derivatives and siloxy-aluminoxane materials used to enhance catalytic effect for polymerization of olefins. The reference speaks in general terms of reaction temperatures being in the range of 25 °C to 150 °C, but Sangokoya says nothing about tailoring curing conditions to precisely define the dimension and geometry of molded parts from these materials. The composition formed in accordance with Sangokoya's process is not a shaped article of commerce such as Applicant is producing.

Sangokoya does not mention two step curing, or does he mention long carefully-controlled end-use temperature cures followed by high temperature hardening steps. These are steps necessary to form an article. The only basis for the citation of this reference is to establish the existence of certain silicon compounds.

With respect to the Kumar reference, it says nothing about maintaining a precise dimension. Shape is NOT dimension. Most assuredly the Kumar parts will undergo significant shrinkage during the higher temperature hardening. The method of the present invention prevents exactly this and differs in this way from Kumar and other typical prior art 2-step curing processes. Applicants define a system that keeps a precise dimension throughout curing.

In the Office Action, the Examiner asserts that Kumar and Muller (sic) Dawes are combinable because they are concerned with a similar technical field, namely molding processes using siloxanes as the molding materials. The Examiner is respectfully requested to note that the Kumar reference does not refer to planar waveguide devices. The skilled artisan would not refer to Kumar when using the Dawes reference as the primary source of prior art.

Kumar et al acknowledge that their process is imperfect where they state that their (imperfect) process does cause significant shrinking of the pattern (see column 8, lines 15-30). Kumar, et al. concede that their process does not produce a reproducible product and they concede that they have no control over obtaining reproducible results by rationalizing that the shrinking which is inherent in their process can have advantages because it results in further miniaturization.

By way of contrast, Applicant unequivocally states (as it is his objective) (and now claims in Claim 1 as to "shrinkage"), that the advantage of his invention is that he is able to make the desired pattern at the exact planned-for dimension, and concurrently, he offers a way to prevent the permanent shrinkage of the formed article which is inherent in the prior art reference to Kumar, et al.

More specifically, with respect to the processing method of Kumar, et al., there are differences which result in a finished product which is a different in kind rather than degree. Kumar, et al. disclose that they first allow the precursor material which is to be formed into the elastomeric stamp to set in the mold for about an hour at room temperature before inserting the mold into the oven. This step, which is a "precure" step, is only superficially similar to the instant process. During the one hour precure step of detailed by Kumar, et al. a modification of

the viscosity of the precursors, e.g., the Sylgard and similar systems discussed, will occur. This modification of precursor may provide some handling benefits; e.g., not having the precursor solution flow out of the mold while lifting and positioning the mold in the oven. It is essential to note however, that the dimensions of the Kumar, et al. pattern are not fixed during the mere 1 hour precure at ambient temperature.

In the method of the present invention, the mold is filled with precursor material and this mold/precursor remains at a precisely controlled end-use temperature for many days or up to a week. This establishes the final cured dimensions of the microcontact printing stamp by having allowed a great majority of crosslink reactions to take place at that final use temperature. The final high temperature reaction cures and hardens the material but does so by reacting only a small residual number of crosslink sites; thereby hardening the element without inducing significant additional chemical shrinkage. Once the product cools down after the high temperature second step, it regains the dimensions it attained during the first long end-use temperature reaction, except for insignificant additional chemical shrinkage caused by the residual crosslinking that took place at the high temperature. It is rendered insignificant by expressly inverting the proportion of chemical crosslinks that are created at each of the two temperatures.

In the method described in Kumar, et al., and others, an insignificant proportion of the crosslinking is created during the room temperature reaction and the vast majority of crosslinking is created at the elevated temperature at which the article is cured. In the process of the present invention, the opposite is true. The vast majority of crosslinking is made to take place at room temperature (by extending the time at that temperature to many days or weeks) and only an insignificant proportion takes place at the higher temperature at which the article is cured.

In reviewing the instant specification and the Kumar, et al. reference cited, certain general similarities do exist, however the specific details of Applicant's invention result in a substantial difference. It is in those differences that the patentability of the present invention resides. The specificities embodied within the instant invention and the lack of relevant disclosure in the

Kumar, et al reference render the Kumar, et al. reference an inappropriate reference with respect to rendering Applicant's invention obvious. There is no basis to combine the three as they relate to totally different disciplines. The Examiner has applied the rejection using the references discussed above, using selective combinations to render obvious the invention without recognizing the substantial differences that exist.

Applicants concede that Kumar, et al. do describe the use of polydimethyl siloxane, just as Applicant does. However Kumar, et al. cure the composition in a very different way, and a way that by their own admission would result in shrinkage (column 8 lines 15-30). Again, this is the substantial difference in kind and not in degree which is necessary to establish "invention."

Kumar, et al. acknowledge their method will cause shrinkage, but offer no way to eliminate or minimize it. Indeed, they rationalize this by claiming shrinkage is desirable because it further miniaturizes the pattern. The standard practice in applications of this type, one does not seek to further miniaturize a pattern beyond what the optical mask defined when making the mold "master." Indeed, except in specialized rare cases such changes are highly problematic.

The method of the present invention offers a way to significantly reduce and at best totally eliminate such changes. The ability to reproduce results from method end product to method end product is achieved, which is not the case in the prior art alone or in combination.

Kumar, et al. use a 2-step cure only in the extreme and broadest sense that they leave the precursor for an hour or so at room temperature after casting before putting it into high temperature oven. Such a time (i.e., one hour) will not result in a fixing of the pattern dimension, but only in establishing the shape and pattern. Applicant emphasizes that his purpose is to gain control over single-digit micrometers in dimension over a total dimension of tens of inches. He seeks such control over these phenomenal scale ratios because of the need for registration of one microscopic circuit pattern with another in a different layer of the circuit which in the example case, are pixels and associated "TFTs"(Thin Film Transistor) and wiring on a flat panel display.

Applicant uses PRECISE control of temperature DURING the "room temperature" stage of the cure. Applicant uses the term "room temperature," but this is the end-use temperature, which is held very constant in a semiconductor clean-room setting. The molding is to be done at that precisely held and maintained temperature. In order to do so, it is necessary to do the curing either in such a temperature controlled environment as a clean room (e.g. make the stamps in a clean room where they will ultimately be used in microcontact printing operations) OR be kept under tightly controlled temperature conditions by hermetic sealing and immersion in a temperature controlled fluid bath.

As to the rejection of Claim 8 over the above cited references and Domeier, et al., the Examiner is again requested to withdraw the Domeier, et al reference in view of the Declaration Pursuant to 37 CFR §1.131 which was attached in a prior submission and is again hereby incorporated by reference herein. Applicant had conceived and reduced to practice the subject matter of the invention prior to the publication and filing dates of the Domeier reference. Thus the skilled artisan would not have the Domeier reference to consult at the time Applicant made his invention.

In addressing Domeier on the merits, the attention of the Examiner is respectfully directed to the fact that Domeier, et al. disclose as their matrix material, a *THERMOPLASTIC*, not a thermoset material. It is well known that "thermoplastics" soften under heat. *The Concise Chemical and Technical Dictionary*, Bennett, Chemical Publishing Company, (1986) at page 1126 states: "thermoplastic, softening under heat, a thermoplastic substance is adequately rigid at normal temperature and under normal conditions of stress but is capable of deformation under heat and pressure." Applicant's material, by virtue of its chemical structure is a thermoset material which: a material that will undergo or has undergone a chemical reaction by the action of

HEAT, catalysts, ultraviolet light, etc., leading to a relatively infusible state." (*Id.*)

Examples of the materials used in Domeier, et al. include poly(methyl-methacrylate), but not elastomeric organic/inorganic polymers of the siloxane type. These are very different materials from the siloxane rubber disclosed and claimed by Applicant.

Contrary to Domeier, et al., the present invention comprises simple molding techniques with respect to microcontact printing stamps, to achieve both the required dimensional integrity for pattern faithfulness and desired mechanical properties, primarily high elastic modulus. It teaches that with the vinyl addition type siloxane precursor mixtures (and others), where crosslinking (curing) can take place at either room temperature or higher temperature, a two-step cure produces the desired combination of properties. This is not possible with Domeier, et al. in view of the materials disclosed therein.

As noted above, Applicant's first step is a room temperature cure, since generally room temperature is the condition at which the stamp will be ultimately used. The stamp is allowed to crosslink at room temperature for some period. During this period of time, the stamp crosslinks and fixes the overall stamp geometry and the printing pattern. This was never contemplated by Domeier, et al. as evidenced in the disclosure.

After this curing step is completed, a second step commences wherein the stamp is brought to a much higher temperature, of 60° C, at which temperature a further cure continues thus attaining a higher elastic modulus. Upon cooling back to room temperature, the original pattern is

restored without distortion and the stamp has the desired higher modulus. Again, Dormeier, et al. do not have such a disclosure to prepare such a product.

The two-step processing described above is used with the intention of using the first step to establish the precise dimension of the molded pattern. The step establishes not just the relative geometry, but also the resulting dimension by being held at a precise temperature within an enclosed mold. Then, once this dimension has been irrevocably established, the material is heated to a higher temperature for hardening.

Even though the material will (and does) expand during the higher temperature curing, it will (and does) shrink back to its original dimension again after cooling to the final use temperature. Neither Dawes nor Domeier, et al. disclose such a phenomenon with their respective final products.

With respect to the references cited to Dawes, Sangokoya and Domeier, not only do these patents deal with entirely different processes, but the disclosures are directed to areas totally different from the teaching objective of the present invention.

The references, which do disclose a cure, say nothing about maintaining a precise dimension. Shaping by molding does not address the specific "dimension" which Applicant needs for his invention to function properly.

Applicant respectfully submits that the specificity of the Dawes, Sangokoya and Domeier, et al. patent references do not rise to the level required to qualify as an appropriate references in combination with respect to Applicant's invention.

In view of the amendments and cancellations made herein, Applicant believes that the claims are in condition for allowance. However if there are issues arising by virtue of this amendment which could be resolved by a telephone conference, Applicant's attorney would be pleased to speak with the Examiner concerning such matter(s) at a mutually convenient time. The Examiner is requested to contact Applicant's attorney by telephone.

If there is a conflict between the Dawes and Muller references in the Official Action, Applicant request that the conflict be resolved by sending a corrected version and that it not be a final rejection.

Respectfully Submitted,


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I hereby certify that this paper is being telefaxed to (571) 273-8300 on the date listed below addressed to Commissioner of Patents & Trademarks, Post Office Box 1450, Alexandria, VA 22313-1450.


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